

Who is Smart? High School Science and Engineering Students' Beliefs about Smartness

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Abstract

The purpose of this research paper is to present findings from an exploratory, qualitative study of high school students' beliefs about smartness. The construct of smartness, which is deeply embedded into all levels of engineering education culture, reflects normative values and can act as a gatekeeper in engineering. Despite the decades of research to broaden participation in engineering education, very little research has explicitly explored the construct of smartness within the context of engineering education and its' exclusionary implications. For this research paper, we focused on the beliefs of high school students as selection of a collegiate major is often chosen during high school and student beliefs about smartness have serious implications for who considers themselves smart enough (or not) to pursue an engineering degree. Although constructions of smartness intersect with race, class, gender, and other social identities, for this exploratory study we chose to investigate the role of gender in the construction of smartness. We utilized semi-structured, one-on-one interviews to explore 22 students' beliefs about smartness with the aim of addressing the following research questions: 1) What do high school science and engineering students believe about smartness? and 2) How do the beliefs about smartness of these students who identify as male and female differ, if at all?

The major findings of this study are: 1) students' beliefs about smartness are complex and divergent, 2) students' beliefs about smartness are related to their interpretations of social indicators of smartness, their epistemic beliefs, and their mindset beliefs, and 3) students who identity as male and female socialized in the same academic environment do not construct smartness in distinctly different ways; however, they may be impacted by smartness very differently based on the stereotypes that exist in their environment. For scholars, a major implication of this research is that when studying smartness, epistemic beliefs, mindset beliefs, and interpretations of social indicators of smartness should all be considered. For the broader community, this contribution provides further evidence for our research agenda of drawing attention to how beliefs about smartness are complex and have exclusionary implications. Social dynamics and ultimately social identities (i.e., gender, race, class, etc.) are interconnected with the social construction of smartness; and therefore, we all must be mindful about how we contribute to the construction of smartness in our academic environments.

Keywords: smartness, K-12, engineering education, epistemic beliefs, mindset beliefs, gender

1. Introduction

The majority of undergraduate engineering programs fail to attract and retain diverse individuals [1]. The minoritization of non-majority identities in engineering education is complex and multifaceted; factors at both the individual and systemic levels contribute to this inequitable outcome. The aspect of this reality that we are interested in investigating (so as to eventually disrupt it) is an implicit, yet powerful, piece of engineering culture: an emphasis on exceptional academic ability, or smartness. To put it simply, the cultural norm is that to go to engineering school (or be an engineer), you have to be "smart" [2]. Of course, what counts as smart is not

neutral or value-free [3]. Only certain types of smartness are recognized as valid for or pertinent to being a "good fit" for engineering [4], typically those associated with analytical ability. This narrow construction of smartness in engineering negates other aspects of ability that are also important in engineering such as ethical reasoning, judgement in the face of uncertainty, or the ability to collaborate and communicate on multidisciplinary teams [5]. Further, the construction of smartness as success in math and science courses reflects majority (White, male, middle-class, etc.) values. Because the trajectories of those who pursue engineering is often set into motion during the K-12 educational experience, the ways in which high school students construct smartness is an important aspect of the overall effort to broaden participation in engineering. However, little research exists to characterize the ways in which high school students in science and engineering classes describe what it means to be smart. To address this gap and build on our understanding of the role that the construction of smartness plays in engineering education, we report on our study of what high school science and engineering students believe about smartness. We interpret these beliefs as reflections of our academic culture in the United States, which perpetuates many normative beliefs that operate to maintain an inequitable system.

2. Background

In the United States, the construction of smartness plays a particularly important role in who becomes an engineer. To start, engineering is commonly believed to be something reserved for the "smartest" among us [2]. One manifestation of this reality is apparent in the fact that elitism is central to engineering culture [6]. The perceived difficulty of undergraduate engineering education is central to the experience of students in engineering school [7]. Students' decision to not pursue engineering is dominated by their beliefs that they aren't good enough at math and science and/or that engineering will be too difficult for them [8]. Furthermore, public messaging conveys that engineering is correlated with confidence in math and science [9]. Indeed, persistence in engineering is correlated with confidence in math and science skills [10]. Our previous work has provided related evidence that students who choose engineering have been given messages throughout their experiences in the K-12 educational system that they are smart [11]. For students who choose engineering, but then leave the major, researchers have shown that one third of them leave because they had poor perceptions of their own academic abilities despite being in good academic standing [12].

The construction of smartness, which plays a central role in the culture of engineering, reflects normative and majority (e.g., masculine and White) values and therefore functions as a gatekeeper in engineering. Just like any other social constructs, there is variation in the construction of smartness across time and space. What counts as smart (or intelligent) has been found to vary across cultures [13-15]. Additionally, intelligence testing has historically been used to perpetuate the systemic dominance of the powerful, majority identities [16-18]. At a more local level, researchers have shown that the construction of smartness that occurs through teacher-student interactions in classrooms reflect our inequitable society, and are therefore oppressive [3, 19, 20]. As we have argued in a previous publication [21], academic constructions of smartness are not value free and therefore act as gatekeepers that maintain the lack of diversity and inclusion in engineering. Figure 1 presents a pictorial representation of how smartness acts as a gatekeeper in engineering education.



We use the term "smartness" in this paper. We choose to do so because in extant literature, smartness is operationalized more broadly than the more common and related term, "intelligence." Smartness of has been conceptualized as implicit theories or ideas about intelligence, which manifest as implicit judgments made during day-to-day social interactions [3]. These implicit judgements reflect the collective values of the participating actors (i.e., teachers and students), which result in the co-construction of smartness at a local level (i.e., within a classroom or education setting). Colloquially, "smart" is often used interchangeably with "intelligent." However, in previous work we have found that students tend to describe intelligence in similar ways, but they describe smartness in very divergent ways [22]. In general, intelligence is a word that often has a narrower focus. Historically, intelligence has been viewed as an explicit measure of innate ability typically based on some form of standardized assessment [23]. In recent decades, scholars have pointed out the problematic issues with intelligence testing, such as being inherently biased [24] or not taking into account how intelligence is culturally constructed (i.e., skills that are valued are culturally dependent) [13]. We recognize that smartness and intelligence are distinct yet overlapping constructs based on work that has come before our own, and we intentionally use the term smart because it is broader and less likely to prompt consistent responses from participants that do not allow for insight into their more implicit beliefs about what makes someone smart.

In this study, we chose to investigate the role of gender in the construction of smartness. This is motivated by the fact that women are often viewed as having less analytical ability than men [25], which is especially problematic in engineering, where analytical ability is a key component of the way in which smartness is constructed. More broadly, researchers have shown that women within higher education, particularly women of color, are often "presumed incompetent" and that the fields that typically attract more women are often viewed as less "rigorous" [26]. Further, fields that are believed to require more innate ability have been linked to a lack of participation of women [27]. Therefore, who is recognized as smart enough for engineering (or not) is gendered.

Despite high school being a critical time for students to decide if they will study engineering or not, and the salience of beliefs about smartness in that decision, little is known about how high school students construct smartness. Decisions made in high school have significant impacts on matriculation into engineering [28]. For students who do matriculate into four year universities, a significant drop off occurs as less than 10% of them declare engineering as a major [29]. We have begun a line of inquiry into the ways in which students who have already matriculated into engineering construct smartness [11, 22, 30, 31]. We have also explored the beliefs that university faculty hold about the nature of intelligence [32]. However, it is with this contribution that we look at the construction of smartness by high school science and engineering students. Other influential work on the construction of smartness in K-12 education, such as work by Hatt [3] draws on empirical evidence from much younger students (e.g., kindergarten). By studying the beliefs of high school students directly, we begin to build an understanding that can lead to disrupting such beliefs that, when held, perpetuate inequity in engineering education.

3. Research Questions

To contribute to the body of knowledge about the construction of smartness in the context of high school science and engineering, this research contribution addressed the following research questions:

Research Question 1: What do high school science and engineering students believe about smartness?

Research Question 2: How do the beliefs about smartness of students who identify as male and female differ, if at all?

4. Methods

This constructivist study seeks to understand student beliefs by exploring their descriptions of their peers who they perceive as being the smartest. By asking students to share their perspectives on what makes someone smart, we can infer their beliefs about smartness and its construction. As such, we conducted semi-structured, one-on-one interviews and used holistic coding to explore high school students' beliefs about smartness. The following section provides a detailed discussion of the methods utilized in this study.

4.1. Participant Selection and Context

We recruited participants for our study from a predominately White public high school in the Midwest. A member of our research team, a White, female teacher at the high school, provided us access to the students. Students were selected from the science or engineering courses taught by the teacher: three sections of Physical Science, one section of Biology, and one section of a project-based introductory engineering course. In total, we selected 22 participants; 11 male and 11 females. Participant selection was based on responses to an online survey taken in class at the beginning of the spring 2019 semester. The survey included demographic information as well as questions related to participants' beliefs about the nature of intelligence. We used a purposeful sampling approach with the goal of selecting participants that would provide insightful and informative responses [33]. The high school teacher also provided valuable insight into which students would likely be willing to participate in interviews and provide information-rich data.

As one of our research questions aimed to explore gendered differences in beliefs about smartness, we also considered gender during selection with the goal of having an even distribution of participants who identify as female or male. Race was also considered; however, as the high school was predominately White, we were not successful in obtaining many participants who identified as other than White. As a result of the number of sections of Physical Science, the majority of the participants were in the 9th grade (i.e., 9th graders are generally placed into Physical Science at the high school). So, many of our participants were at the beginning of their high school experience; however, we were able to include some participants who were further along in their experience. Table 1 provides participant demographic information.

Pseudonym	Gender	Race	Academic Level	Course
Danny	Female	White	9	Physical Science
Donald	Male	White	9	Physical Science
Eddie	Male	White	10	Engineering Innovations
Ella	Female	White	9	Physical Science
Eve	Female	Multiracial	9	Physical Science
Harry	Male	White	11	Engineering Innovations
Jack	Female	White	12	Engineering Innovations
Jacob	Male	White	9	Physical Science
Jared	Male	White	9	Physical Science
Jarvis	Male	White	9	Physical Science
Kyle	Male	White	10	Biology
Liz	Female	White	9	Physical Science
Lucy	Female	White	9	Physical Science
Mary	Female	White	9	Physical Science
Matt	Male	White	9	Physical Science
Meg	Female	White	9	Physical Science
Molly	Female	White	10	Biology
Monk	Male	White	9	Physical Science
Rayne	Female	White	9	Physical Science
Rikki	Female	White	9	Physical Science
Robert	Male	Black or African American	11	Engineering Innovations
Zeke	Male	Did not identify	9	Physical Science

Table 1: Demographic information as self-reported by participants

4.2. Data Collection

Our goal was to understand the subjective experiences and perceptions of each participant; therefore, we utilized semi-structured, one-on-one interviews as our means of data collection [34]. Three members of the research team conducted the interviews; one White, female graduate researcher, one Latina graduate researcher and one White, male undergraduate researcher. We conducted the interviews over a three-day period in private conference rooms at the high school during the participants' regularly scheduled science or engineering courses. The teacher, a member of the research team, was aware of which students participated in the interviews, however, to protect participant confidentiality, we did not share any interview data with the teacher until after the semester had ended. Our interview protocol was developed with questions to collect data about 1) students' beliefs about the nature of intelligence (i.e., fixed versus growth mindset), 2) science self-efficacy, 3) career aspirations, 4) views on the gender gap in STEM, and 5) students' beliefs about smartness. In this paper, we focus on the data collected from the portion of the interview related to beliefs about smartness. Specifically, we asked the participants to identify the smartest peer in their science or engineering class and to describe the characteristics that make them the smartest.

The interviewers asked follow-up questions if clarification or further detail was needed to better understand the participants' perceptions. Follow-up questions regarding their smartest peer in a non-STEM course were also asked. We audio recorded the interviews and then had them transcribed by members of the research team or a professional transcription service. All transcripts were checked for accuracy and cleaned by a member of the research team, removing any identifiable information. Prior to the interview, the participants were given the option to select a pseudonym. If they did not select a pseudonym, one was assigned to them.

4.3. Data Analysis

We began the analysis with two members of the research team (authors) attempting thematic coding with the goal of finding consistent themes across the data for what high school students believe about smartness. We created a spreadsheet to summarize the participant responses expecting to find common themes across the participants' description of smartness as well as to enable comparisons between male and female participants. However, this process instead revealed significant variation in the responses, which meant that there were no common themes across participants in terms of how they constructed or defined smartness. So, we pivoted to utilizing holistic coding, which is an exploratory coding method used to find underlying patterns or issues across the data at a macro level [35]. We created two Word documents, one containing the transcript excerpts about smartness from the female participants and one with the excerpts from the male participants. We then read each document and generated holistic codes to capture patterns in what our male and female participants were communicating about what makes someone smart. Next, we compared the codes we generated independently, discussed, and then iterated while mapping the codes back to the empirical evidence in the transcripts until we reached agreement on the findings and our interpretation of them.

4.4. Researcher Positionality

The research team consisted of five members all of whom identify as White: one female assistant professor, one female graduate researcher, one Latina graduate researcher, one female high school teacher, and one male undergraduate researcher. With the exception of the high school teacher, we all have degrees or are pursuing degrees in engineering. Also, we've all had experience with being identified as smart in high school through placement in honors or other advanced placement courses or through our social interactions with peers or teachers. These experiences were indeed impactful on our own decisions to pursue engineering, which motivates this investigation. In addition, the female members of the research team had varying levels of experience with their smartness being challenged or minimized because of their gender, which informs our prioritization of gender among many potential aspects of human diversity that matter for who gets recognized as smart. While our positionalities have the potential to help us identify and relate to the participants, we also recognize the personal contexts that motivate this research as well as the power dynamic between the researchers and the participants: college educated adults, and the high school students. We had the student members of our team conduct the interviews, and they tried to build rapport with the participants to make them feel as comfortable as possible. Finally, as our findings indicate, we found no major differences in how the male and female students described smartness, despite our initial suspicion that there would be based on our own positionalities and experiences.

5. Findings and Discussion

5.1. Research Question 1: What do high school science and engineering students believe about smartness?

During our initial thematic analysis, it was difficult to identify common themes across all, or even the majority, of the participants. This was due to the considerable variation in the students' responses. The participants used phrases like "good grades," "hard work," "natural ability," "confidence," and many others to describe their smartest peers. They also frequently contradicted themselves and each other in their responses. For example, some participants described the smartest student as the one who is always actively participating in class, while others described the smartest student as the one who is quiet and studious. We should note that beliefs, especially when deeply held, are not always coherent [36-38]. Due to the lack of common themes in the data, the first significant finding of this study is that the students' beliefs about smartness are complex and divergent. This finding aligns with our previous work exploring the complex and intertwined nature of first-year engineering students' identities and beliefs about smartness [11].

When we pivoted to a more holistic data analysis approach, some overarching patterns in the way the participants framed smartness at the macro level became evident. As we explored and discussed these patterns, we discovered that the responses across the participants generally revealed insights into three more specific categories. High school students' beliefs about smartness are related to: 1) how the students interpreted social indicators of smartness, 2) their epistemic beliefs (beliefs about the nature of knowledge), and 3) their mindset beliefs (beliefs about the nature of students the findings for our first research question and provides empirical examples of each holistic code.



5.1.a. Students' Beliefs about Smartness are Related to their Interpretation of Social Indicators

Students' beliefs about smartness are related to their interpretations of social indicators. In other words, students decide who is smart by watching what happens in the classrooms or in the school more broadly. Our participants described their smartest peers as those who engage in social settings in particular ways. For example, they know who is smart because they "sound smart," are confident, get the highest grades on tests, participate in class, etc. We further broke down these interpretations of social indicators of smartness into informal and formal aspects. This aligns with extant literature indicating that smartness can be assessed through artifacts such as grades but also more informally based on social interactions [3]. The participants discussed how they interpreted several informal social indicators which included seemingly usual interactions but led the participants to believe that someone is or is not smart. The quotes below provide examples.

"It's the way she can say it that makes her sound smart." – Jarvis

"When [the teacher] asks a question, she usually has her hand up, and she, I mean, she works hard in that class and you can tell." – Mary

In addition to their interpretations of informal indicators of smartness, smartness was also interpreted through more formal indicators of ability. In general, these indicators include grades, standardized test scores, and placement into honors or advanced classes. The participants interpreted these indicators differently; some placed a very high value on grades while others did not. However, as the quotes below indicate, the participants were generally very aware of these formal indicators of smartness. "Yeah, like, okay, being smart in these classes would probably entail getting the best grade. As you just want to know who's smartest in this classes, um, whoever get the highest grade." – Ella

"She's really smart. She's taking all, all honors classes and all advanced classes." – Jacob

Ultimately, this finding provides further evidence for the local and social construction of smartness in schools [3]. The participants assigned smartness based on their implicit judgements of social behavior. Implicit judgements of smartness can have significant implications as researchers have shown that they lead to social positioning and power and privilege [3, 20]. This finding also highlights the importance of our role as educators and the ways in which learning is facilitated in our classrooms. The attitude of the teacher and the student relationship with authority are tied to who gets identified as smart. For example, Hatt [3] points out during her classroom observations that the teacher was often hyperaware of the behavior of the male students of color in relation to the White students, and as such the students in the class then associated discipline with smartness, which ultimately perpetuated the belief that certain male students of color were not as smart as the White students. This example illustrates the role that we as educators play in how smartness is constructed within classrooms. Therefore, we all have agency to engage with students in ways that disrupt some of the normative beliefs about what it means to be smart.

5.1.b. Students' Beliefs about Smartness are Related to their Epistemic Beliefs (nature of knowledge)

As the participants described their smartest peer through their interpretation of social indicators, they also tended to discuss smartness in ways that was related at a meta level to their epistemic beliefs. Epistemic beliefs are beliefs about the nature of knowledge. These beliefs consist of our perceptions of knowledge such as its source, certainty, and construction [39]. In this study, the participants often described the nature of knowledge in ways that are reflective of naïve epistemic beliefs, such as the belief in absolute knowledge that is handed down by an authority [40-42]. Several participants described the smartest student as those who can recite facts back to the teacher (i.e., an authority figure). To these participants, smartness is knowing the objective answers to the questions asked and valued by the teacher. The following quotes provide examples of this finding from the interview transcripts.

"He's always got the correct answer, like when he, when she [teacher] calls on him." - Meg

"He always answers everything; he always has, like, previous knowledge. Um, he knows, like, the specifics, all that kind of stuff." – Monk

This finding aligns with extant research showing that high school students tend to have more naïve epistemic beliefs [40]. Scholars argue that as students receive more education, they develop more sophisticated epistemic beliefs. However, some participants in the study did have

slightly more sophisticated epistemic beliefs. Sophisticated epistemic beliefs typically include beliefs about the subjective, relative, or uncertain nature of knowledge [40-42]. Although these participants did not explicitly express these views, they were able to convey a belief that being smart includes the ability to reflect more critically or deeply on the material being introduced by the teacher. In the example below, the participant describes how he (self-identified as the smartest student) can make these deeper connections.

"How I analyze things is a lot more advanced and, uh, deeper than other students." – Eddie

Extant researchers within engineering education have explored epistemic beliefs in the context of educational issues such as engineering problem solving [43, 44] and student development [45] as well as more broadly in engineering education culture [6]. Researchers have also shown that aspects of epistemic beliefs are fundamental to students' identities as learners, which can be critical for student retention in engineering [46]. Given the breadth of research on students' epistemic beliefs within and the critical role they play, our finding linking epistemic beliefs to beliefs about smartness further illustrates the pervasiveness of smartness within engineering education culture.

5.1.c. Students' Beliefs about Smartness are Related to their Mindset Beliefs (nature of intelligence)

In addition to participants' beliefs about smartness being related to their beliefs about the nature of knowledge, their beliefs also revealed a connection to the participants' beliefs about the nature of intelligence. Beliefs about the nature of intelligence and epistemic beliefs are closely related, and some scholars have hypothesized that beliefs about the nature of intelligence are a dimension of epistemic beliefs [39]. However, in recent years, beliefs specifically about the nature of intelligence have been studied through the popular framework of Carol Dweck's Mindset Theory [47]. In her work, Dweck theorizes that people tend to believe that intelligence is either innate, meaning that people are born with a fixed amount of intelligence (i.e., fixed mindset) or malleable, meaning that intelligence can grow with focused effort (i.e. growth mindset). In our study, several participants were advocates of the power of hard work and effort, which indicates growth mindset beliefs. Some participants described their smartest peer as someone who works hard and puts forth the most effort. In addition to effort, participants also described smart students as those who are willing to ask for help when needed, which also reflects growth mindset beliefs. The quotes below provide examples.

"I think that it's not, it doesn't matter by the grade, I think it matters by if you try. Cause I don't think it's very smart to not try." – Eve

"And when she doesn't understand something, she does ask questions." – Mary

Conversely, other participants described their smartest peers as those that are innately intelligent (i.e., born smart). These participants' descriptions reflected fixed mindset beliefs. For example, the quotes below demonstrate the participants' belief that smart people are naturally more intelligent than those who have to rely on effort.

"I mean, someone who gets an 86 might actually have more natural intelligence, or be smarter, than someone who got a 98. But that person who got the 98 might just have worked harder." - Ella

The belief that smartness and effort are inversely related (you are either smart or you work hard) was also found in our previous study of first-year engineering students' beliefs about the nature of intelligence—many students believed that if someone is smart, effort should not be required [11]. This finding also aligns with research that provides evidence for the pervasive belief in Western culture that effort and smartness are distinct, inversely related constructs [14].

In addition, some participants' responses demonstrated the complex and often contradictory relationship between beliefs about smartness as innate or as a function of effort. Even for the participants that spoke of the importance of effort, our analysis revealed that they hold underlying beliefs in innate ability. The quote below shows a participant confronting his own conflicting beliefs while describing his smartest peer someone who scored very high on the ACT despite putting forth little effort in their math class. It's important to note that prior to this portion of his interview, he spoke passionately about how effort leads to success and achievement.

"He got a 36 on his ACT...And yeah he's really smart. And I'm, I don't know. I- I'm con- I get sometimes confused why, because I don't, like we're in [math] and I'm working hard and it seems like he doesn't have to do any hard work and he just knows it. And so I'm- I –I don't know why." – Harry

In summary, the answer to our first research question is that the beliefs that our high school students participants hold about smartness are complex and divergent. When analyzed holistically, their beliefs about who counts as smart are related to how they interpret social indicators of smartness, their epistemic beliefs, and their mindset beliefs. In the next section, we will discuss the role of gender in the construction of smartness.

5.2. Research Question 2: How do the beliefs about smartness of students who identify as male and female differ, if at all?

While exploring high school students' beliefs about smartness, we also sought to find any differences in how the students who identify as male and female described smartness. This was motivated by our understanding of how the gendered constructions of smartness can operate as exclusionary to females. However, during our analysis, we found no consistent differences between the male and female participants' beliefs about smartness. We suspect that this may be due to the fact that they are all participating in the same educational system. Therefore, our final finding is students who identify as male and female socialized in the same academic environment do not construct smartness in distinctly different ways.

However, we did find differences in how the male and female participants' *experienced* smartness as a result of their academic environment. As Hatt argues in her work, smartness is something "done" to others [3]; meaning that we assign smartness to others based on collective normative values. So, although the male and female participants describe their smartest peers in similar ways (all complex and divergent), they may be impacted by these social constructions

very differently. For example, the quote below captures one female participant's experience with the girls at her school being perceived as not as smart as some of the boys.

"I don't think I could be as smart as [smartest student] because he has solike there's just something about him that makes him want to strive. Like, I want to strive, but I have always just felt, like, set back and I- I've always felt that I wasn't, like, good enough to be smart. And people have always just like looked down and I feel like the girls in my grade are looked down upon, because, like, we aren't as smart as some of the boys, but that's just how it is." – Liz

In addition to this finding providing further evidence for the social construction of smartness in schools [3, 20], it also provides evidence for how stereotypes (i.e., girls are not as smart as boys) work to reproduce the status quo for participation in science and engineering as indicated by this participant's seemingly defeated acceptance of the stereotype based on her experience of smartness at school. Finally, this finding adds to the body of evidence in literature that societal stereotypes about who is smart enough are deeply connected to how the construction of smartness minoritizes non-male individuals [26, 48].

6. Limitations

The most significant limitation of this study is that it was conducted at a predominately White high school with mostly White participants. As such, the findings are limited and only transferable to a similar population of students. This work provides insight into the normative ways that smartness in constructed in high schools; however, it is critical that the experiences of students from all social, personal, and intersecting identities be explored to truly understand how smartness is constructed and experienced in high school environments.

7. Conclusions

This paper presents findings from an exploratory, qualitative study of high school students' beliefs about smartness. The construct of smartness, which is deeply embedded into all levels of engineering education culture, reflects normative values and can act as a gatekeeper in engineering. Our focus for this study was on high school students since selection of a collegiate major often occurs during high school and the beliefs these students hold can have serious implications on who considers themselves smart enough (or not) to pursue an engineering degree. The major findings of this study are; 1) students' beliefs about smartness are complex and divergent, 2) students' beliefs about smartness are related to their interpretations of social indicators of smartness, their epistemic beliefs, and their mindset beliefs, and 3) students who identity as male and female socialized in the same academic environment do not construct smartness in distinctly different ways; however, they may be impacted by the constructions of smartness very differently based on the stereotypes that exist in their environment. These research findings are helpful to other scholars who wish to investigate beliefs related to the broad construct of smartness as well as to engineering educators, especially those who may teach or advise students at the high school or early collegiate level. For scholars, a major implication of this research is that when studying smartness, epistemic beliefs, mindset beliefs, and interpretations of social indicators of smartness should all be considered--our findings suggest

that they are closely related. For the broader community, this contribution provides further evidence for our research agenda of drawing attention to how beliefs about smartness are complex and have exclusionary implications. Social dynamics and ultimately social identities (i.e., gender, race, class, etc.) are interconnected with the social construction of smartness, and therefore, we all must be mindful about how we contribute to the construction of smartness in our academic environments.

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